

REMARKS

Claims 1, 2, 4, 6, 8, 9 and 11-16 are all the claims pending in the application.

Preliminary Matters

Claim 1 is amended to recite “wherein the volume of said bumps is less than the volume of said apertures”. As was brought to the attention of the Examiner in an interview on July 28, 2009, this claim amendment corrects an unintentional typographical error in claim 1.

Claim Rejections - 35 U.S.C. § 103

Claims 1, 2, 4, 6, 8, 9, and 11-16 currently stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Qi (U.S. Patent No. 6,774,497) taken with Fujimori (U.S. Patent Pub. No. 2004/0046252).

The Examiner, in the Final Office Action, asserts that the feature; “wherein the volume of said bumps is less than the volume of said aperture”, recited in claim 1 (currently amended) and claim 6 (previously presented) of the present application is disclosed in FIG. 2B of Qi. However, Qi does not teach or suggest “the volume of said bumps is less than the volume of said apertures”, as the Examiner asserts. The reasons the Examiner is in error are as follows.

FIG. 2B of Qi shows connective bumps 242 sitting in openings of solder mask 250. However, Qi does not indicate or suggest the relationship between the volume of the bumps and the volume of the openings formed in the solder mask. Furthermore, FIG. 2B does not show anything to indicate the relationship in terms of the size of the volume thereof (such as scale). Therefore, there are no clear grounds to support the above-described Examiner’s assertion.

Qi, col. 6, lines 65-67, describes a structure in which a solder mask 250 (a solder resist) and pads 242 (electrode pads) may overlap. Such a structure is called a SMD (solder mask defined) structure. On the other hand, a structure described in FIG. 2B of Qi is generally called a non-SMD structure.

The SMD structure and non-SMD structures are different in terms of relationship between the thickness of the solder resist and the volume of the apertures formed on the solder resist, and the shape of the bumps after connection. The Applicants specifically disclose the condition of the relationship that “the volume of the bumps is less than the volume of the apertures” is established, in FIG. 4 for the SMD structure and in FIG. 6 for the non-SMD structure. However, Qi only mentioned that their invention is applicable to both a SMD structure and non-SMD structure, but does not disclose the detailed conditions thereof.

For example, in the non-SMD structure disclosed in FIG. 2B of Qi, the bump diameter is set to a maximum around the center of the bump height. In regard to the structure, the diameter of the apertures of Qi has to be remarkably large compared with the diameter of the electrode pads for the relationship that “the volume of the bumps is less than the volume of the apertures” to be established. In this case, the thickness of the solder resists, the diameter of the apertures, the diameter of the electrode pads, and the volume of the bumps are required to be strictly controlled to prevent reducing the electrical connection reliability due to the occurrence of voids. Qi does not advert to this aspect whatsoever.

On the other hand, in the case of the SMD structure, the diameter of the electrode pads corresponds to the diameter of the apertures formed on the solder resist so it is obvious that the

relationship that “the volume of said bumps is less than the volume of said apertures” cannot be established when the structure of FIG. 2B is substituted to that of the SMD structure in Qi.

With regard to the semiconductor device of the SMD structure, when the relationship that “the volume of said bumps is less than the volume of said apertures” is established and electrical connections between semiconductor elements and electrode pads are allowed, the bumps are in contact with the electrode pads and then the bumps are deformed inside the aperture portions and the diameter of the bumps is maximum where it is connected to the pads. Each drawing of the present application is shown in light of this aspect. Qi does not disclose bumps having such configuration. In the semiconductor device disclosed in FIG. 2B of Qi, the diameter of the bumps is maximum around the center of the bump height. This indicates that, in FIG. 2B of Qi, the volume of the bumps is **larger** than the volume of the apertures. Thus, Qi does teach or suggest “the volume of said bumps is less than the volume of said apertures”, as is required by claims 1 and 6.

As it is described at length, the structure disclosed in FIG. 2B of Qi and the semiconductor device of claims 1 and 6 are clearly distinguished. Fujimori also fails to cure the deficiency of Qi discussed above. Therefore, Applicant submits that claims 1 and 6 are patentable over the combination of Qi and Fujimori.

Claims 2, 4, 8, 9, and 11-16

Applicant submits that claims 2, 4, 8, 9, and 11-16 are allowable at least by virtue of their dependencies.

AMENDMENT UNDER 37 C.F.R. § 1.114(c)
U.S. Application No.: 10/594,844

Attorney Docket No.: Q97404

Conclusion

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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